A SCHEME FOR ALLOCATING MARINE POLLUTION COSTS-A CASE STUDY OF İZMİT BAY AREA

M.B.A. THESIS

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A SCHEME FOR ALLOCATING MARINE POLLUTION COSTS:A CASE STUDY OF İZMİT BAY AREA

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BY

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JUNE, 1994

I certify that I have read this thesis and in my opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Business Administration.

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ABSTRACT

A SCHEME FOR ALLOCATING MARINE POLLUTION COSTS
A CASE STUDY OF İZMİT BAY AREA

BY

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JUNE, 1994

This study determines what should be the contribution of each firm to the cleaning up cost of the eastern part of İzmit Bay. The total initial investment of cleaning up the eastern part of the bay consists of: the costs of the inciniration plant, waste water purification plant, collector, and solid waste depositing plant. As the marine pollution is considered in this study, calculations are based on the initial investment costs of collector and waste water purification plant. At the first step, establishments are ranked and scaled with respect to their daily total discharge in volume. After this initial stage two models are designed to determine the contribution costs. In the first model costs are determined for each establishment, where as, in the second model costs are determined per parameter for each establishment. The results indicate that the second model is more accurate since, it is possible to be more specific in cost allocation.

ÖZET

DENİZ KİRLİLİK MALİYETİNİN DAĞILIMI İÇİN SINIFLANDIRMA-İZMİT KÖRFEZİ ÇALIŞMASI

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Haziran, 1994

Bu çalışma, İzmit Körfezi doğu bölgesinde bulunan her kuruluşun körfez temizleme maliyetine katkı paylarını belirlemek için yapılmıştır. Doğu bölgesini temizlemenin ilk yatırım maliyetleri; yakma tesisi, atık su arıtma tesisi, kollektör ve katı atık depolama tesisleri maliyetlerinden oluşmaktadır. Bu çalışmada deniz kirliliği gözönünde bulundurulduğundan hesaplar atık su arıtma tesisi ve kollektör üzerine kurulmuştur. İlk adımda kuruluşlar günlük atık miktarına göre sıralanmış ve derecelendirilmişlerdir. Bu ilk adımdan sonra katkı paylarını belirlemek için iki model izlenmiştir. İlk modelde maliyetler kuruluş başına belirlenmiştir, oysa ikinci modelde katkı payları her kuruluş için parametre başına belirlenmiştir.

Sonuçlar, maliyet dağıtımının ikinci modelle daha doğru ve daha spesifik olduğunu göstermektedir.

ACKNOWLEDGEMENTS

I am grateful to Assoc. Prof. Can Şımga Mugan for her supervision and constructive comments throughout the study. I would also like to express my thanks to the members of the examining committee for their contribution, to my father, to Ercüment Bölükbaş and to Veziroğlu İnşaat for their support throughout my study.

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1. INTRODUCTION

The purpose of this study is to determine what should be the contribution of each firm to the cleaning up cost of the eastern part of İzmit Bay. In this way, a cost allocation scheme of marine pollution is constructed.

İzmit area is examined in this study because the area is developing as the densest center of industry in Turkey. The bay is polluted at an increasing rate by domestic waste water, effluents and discharges from industrial premises, greasy wastes from ships, industrial gaseous wastes and particle pollutants, and eraded earth and organic pollutants introduced by the streams. The production in the area constitutes a large amount of total production in Turkey. Besides the industrial development, the region is rapidly growing as a commercial center as well.

The pollution in the bay area has reached to levels threatening human lives and marine life, and therefore there is a need for immediate precautions and solutions to prevent further pollution. The government spends huge amounts of money annually to cover the damage that the pollution has caused on human life.

It is believed that more serious steps should be taken to prevent and solve environmental problems causing pollution and damaging natural life. Environmental regulations should be revised and applied so that establishments will be under regular control and

standards will be obeyed seriously. İzmit region is a good example to examine, since pollution level has reached to threatening levels. Another reason to examine this region, is that there is a project under construction that consists of; inciniration plant, collector, waste water purification plant and waste solid depositing plant in eastern part of the bay. This project cost will help us in determining contributions to the cleaning up cost of each establishment.

The focus of this study is the, marine pollution and thus only initial investment costs of the collector and waste water purification plant are taken into consideration. Two methods are then proposed to determine the contributions to the cleaning up cost.

In chapter 2, basic concepts about environmental pollution are explained. In chapter 3, present condition of marine pollution in Turkey and İzmit Bay is described. Finally, in data gathering, model specification and application, by the help of the loadings in volume of each parameter for each establishment total daily discharges are determined and, a ranking from the most to the least polluting establishment is obtained. Based on the ranking system proposed, annual payments by each establishment are determined. Meanwhile, for each establishment, annual contributions that could be collected for the environmental pollution prevention fund as stated by the Environmental Regulation No. 2782, is calculated. Proposed payments and payments that could be collected for the fund are compared to observe what percentage of cleaning up cost could be covered from the fund. In the second method, starting with the percentages of parameters for each establishment, cleaning up cost is determined per parameter for each establishment.

2. BASIC CONCEPTS ABOUT ENVIRONMENTAL POLLUTION

2.1. GLOBAL ENVIRONMENTAL POLLUTION

In considering the impact of industrial activity on environmental quality and on health, one needs to remember that the environment was not really taken seriously until the beginning of the 19th century. Before then, there was the concept of "Garden of Even" which resembled clean, peaceful and fertile environment. In the past few years' environmental protection has become a challenging scientific task. Signs of environmental awareness and a willingness to cooperate on an international level are increasing. A number of international conferences on environment have been held and more are scheduled. (Dohlberg, 1985)

The industrial development resulting in increased level of industrial pollution of the environment has already begun disturbing the ecological equilibrium in many regions of the globe. Most production and consumption activities have some effect on the physical environment.

The rise of the petroleum and chemical industries has introduced vast quantities of toxic chemicals into water and soil. The synthetic-chemical industry is largely a product of post 1945 economic and scientific development. Just before World War II the U.S. produced only about 1 billion pounds (0.45 billion kilograms) of synthetic

organic materials annualy. By 1950, production had already passed 20 billion pounds (9 billion kilograms) and by 1985 it had reached 225 billion pounds (101 billion kilograms). Roughly half of the 70,000 chemicals now in commercial use are considered by the governments of the United States and the European Economic Community (EC) to be definitely or potentially harmful to human health. (WHO, 1990)

Commercial fertilizer consumption world wide jumped from 14 million metric tons in 1970 to an estimated 146 million metric tons in 1989. These chemical compounds, which have been so important in agricultural production also pose a potential threat to human health worldwide through their disposal into water supplies. (WHO, 1990)

Oil, which has been the world's main source of energy for industry and transport, has also been discharged directly into the soil in the process of shipment to markets. Official data on oil discharges into the seas from shipping are lacking, but it is estimated that by the 1990's such discharges had reached roughly 1.5 million metric tons annually. (WHO, 1990)

The rise of nuclear power as a source of energy has led to the disposal of low level radioactive wastes into the oceans. The cumulative volume of such nuclear wastes raise from less then 20,000 metric tons in 1967, with a negligible radroactivity, to almost 100,000 metric tons with a million curies of radioactivity in 1984. (WHO, 1990)

Coastal areas reflect the effects of rapidly growing concentrations of population, industrialization, mariculture, tourism, eutrophication and plankton blooms from sewage and nitrates, plastic litter, lost habitats from the destruction of beaches, coral reefs, wetlands and mangrove forests. Coastal area destruction for land-based activities is now the major cause of immediate concern in the marine environment on a global basis. (J.Vig, 1990)

Oceans and seas are fed by rivers through many estuaries and outlets which also act as channels for agricultural, industrial and chemical effluents. The great oceans have a high capacity for absorbing organic and inorganic materials from both man made and natural sources. The extent of this capacity can only be speculated, but the effects of pollution on coastal zones and enclosed seas are very apparent.

Economic activity, production and consumption, influences the natural environment in three fundamental ways;

1. by the occupation of space
2. by the extraction of raw materials, such as minerals, oil, fish, etc.
3. by the discharge of residuals that find no further use in economic activities.

In order to analyse the relationship between economic activities and pollution, it will be convenient to distinguish between the following three steps;

1. the relationship, between economic activities and the discharge of residuals.
2. changes in nature due to these discharges
3. social costs related to these changes in the natural environment. (Strom, 1988)

Discharge of residuals is a fundamental feature of economic activities. The through put of materials is illustrated in Figure 1.1. Materials of substances used in economic activities are incapable of disappearing in a physical sense. We can draw up a material balance of the economy. The amounts of materials or substances extracted from nature must either remain in the economic cycle, or be discharged and return once again to the natural environment. (Strom, 1988)

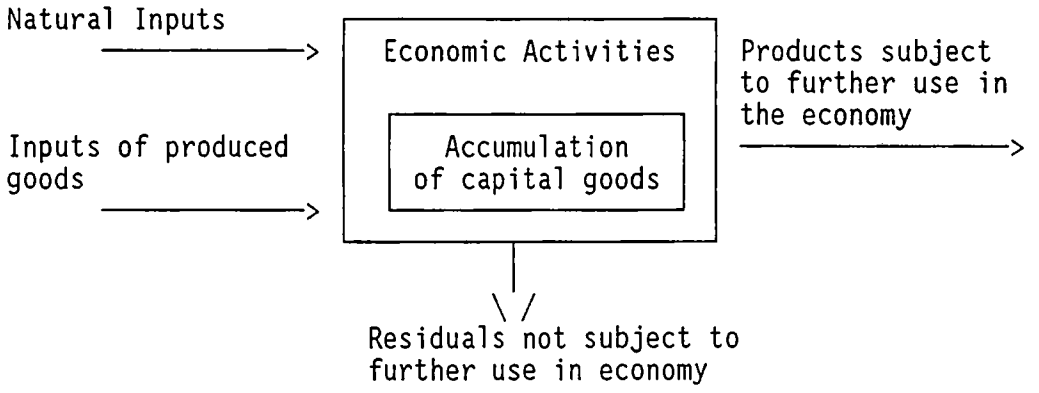

Figure 1.1. The Throughput of Materials in the Economy (Strom, 1988).

Residuals can be classified according to various criteria; for example, according to physical conditions and chemical composition or according to the effects of the discharges. The main type of residual are;

Material residuals;

solid

fluid

gaseous energy residuals;

heat

noise

radiation. (Strom, 1988)

For the sake of simplicity the natural environment can be divided into recipients. The main types of recipient are air, land and water. It is presumed that the state of recipients can be described in terms of certain measurable conditions, which we may call environmental indicators. Examples of such indicators are;

- the oxygen content per volume unit of water;
- the quantity of fish in a lake;
- the amount of bacteria per volume-unit of water;
- the acidity of water measured in pH values;
- visibility depths of water;
- the quantity of algae in water;
- concentrations of sulphur compounds, dust, carbon monoxide, mercury, lead and nitrogen compounds in the air;
- the number of birds within a certain area.
- the probability of contracting ailments such as bronchitis, asthma, lung cancer and thrombosis. (J. Vig. 1990)

Under constant external conditions balance will occur in the recipient between the various environmental indicators. Any

alterations in the factors involved in this balance will displace the equilibrium. The magnitude of this displacement will depend on the influence exercised by the factor in equilibrium oxygen, water and dissolved nutrients are factors included in the system that take the form of a more or less continuous supply. If the continuous supply of important materials is increased or reduced, some time will elapse before equilibrium is reestablished. The observed environmental indicators can often show a time variation, as illustrated in Figure 1.2.

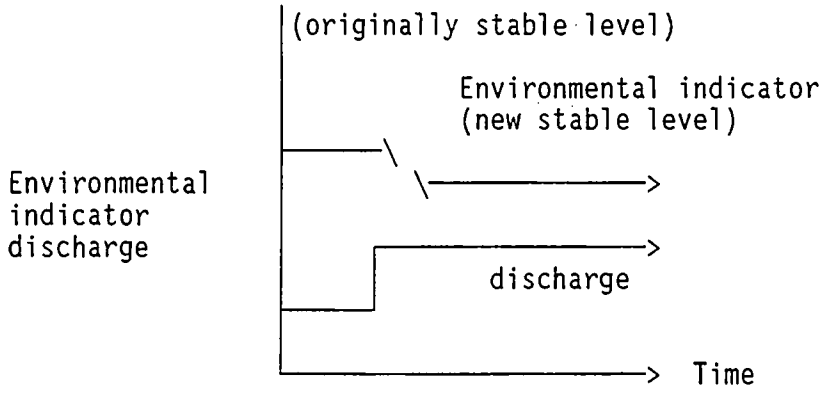

Figure 1.2. Relationship between the level of the indicator and the stepwise changes in the discharges in the discharge of a residual. (J.Vig, 1990)

When the supply of residuals suddenly increases, some organisms may after a while be reduced in number or possibly die out, while others will increase in number. If the external change is not excessive, a new equilibrium will be established. However, it is also possible to imagine that if the sudden increase is sufficiently great, then the decrease in the level of the indicator may be reduced to almost zero.

2.1.A. ECONOMIES OF ENVIRONMENTAL POLLUTION

One approach to an economic analysis might be to consider the natural environment as a form of production capital; nature 'produces' certain goods and services. In order to arrive at the principle problems involved, the services provided by nature can be divided into three main categories;

1. waste disposal services
2. extraction services
3. amenity services. (Portney, 1990).

Discharge of residuals from economic activities is countered by a waste disposal service provided by nature. The exploitation of substances existing in the natural environment, such as minerals, oil, forest, fish, water, oxygen, etc. is countered by extraction services. Amenity services, here intended in a very wide and comprehensive sense, may include everything from open air activities, angling, bathing, etc. to a aesthetic experiences.

Pollution means that discharge of residuals reduce the quality and scope of extraction and amenity services. Providing mechanisms that ensure effective utilisation of resources is one of the main tasks of the economic theory. In a free market the price mechanism plays a dominant role in the allocation of resources for various purposes. The question here is whether the negative effects of

pollution are reflected to a sufficient degree in the production cost of the goods and services responsible for this pollution. It can be concluded that negative effects of pollution have not been absorbed in the market system sufficiently, which means that economic activity creates negative effects that are not reflected in market prices. (Portney, 1990)

The principal economic solution to problems involving indirect effects as applied to problems of pollution may be said to involve the following:

1- finding the prices for waste disposal services corresponding to the social marginal cost, measured in terms of alternative use of the natural environment to supply us with extraction and amenity services;

2- establishing systems so that decision making bodies take these prices into account. (Portney, 1990).

2.1.B. "TAXMAN COMETH" MODEL

Several models have been developed to determine the charges that a polluting establishment has to pay. "Taxman Cometh" is one of the models that determines charges of polluting firms, considering purification costs and environmental damage. It is assumed that the authorities have decided to impose effluent charges as a means of regulating the amount of pollution. The environmental protection authorities are in a position to measure conditions in the recipients

involved, and arrive at a charge that will give the environment in the recipient a desired quality. This system presupposes that firms respect the rules and regulations for effluent charges. If no supervision of any kind is exercised, firms will be in a position to evade charges by discharging more effluent that their own charge returns would warrant. For this reason the environmental protection authorities, as well as the tax authorities, are anxious to supervise the sources of discharge. It is also assumed that the authorities are not in a position to undertake continous measurements, either for economic or for technical reasons. The charge has to be pard for a period taken as a whole (Strom, 1988).

Two approaches available to the authorities in effecting a solution to the charge is considered:

1- the discharge amount for the entire year is estimated by making a random check on one of the days. The firm must then pay a charge equal to the result of the random check multiplied by 365 days.

2- Firms themselves submit reports on their daily discharge, either implicitly in the payment of an effluent charge, or explicitly in a return of charges to the authorities. A random check is carried out on one day, and the result is then compared with the information the firm has submitted in its effluent charge return. If there is no agreement between the result of the discharge check and the information, a penalty is imposed on the firm. (Strom, 1988)

A simple partial pollution model is introduced at this stage of the study. It can be assumed that a situation in which a number of factories or plants are discharging a residual that affects the condition of a recipient. The plant is described in terms of three relations: a cost function which tells how much it costs to produce the product in the cheapest possible way; a discharge function that acts as a link between production and the discharge of residual; and a purification cost function, which tells how much it costs to purify (Strom, 1988).

It is assumed that the amounts firms wish to discharge every day in the course of a year, without any effluent charge, are given and known magnitudes for each firm. These primary or maximal discharges may, for example, be unambiguous functions of production levels every day in the course of a years. The firm's purification cost function could be defined as;

$$C_i = C\ (\bar{Z}_i - d_i) \quad C' > 0,\ C\ (0) = 0$$

where Z_i is the given primary discharge in the subperiod; and d_i the actual discharge to the recipient. The actual purification cost function is the same for all subperiods, while the given primary discharges and the actual discharges may vary from one sub-period to another. (Strom, 1988)

The social problem of adjustment is to minimise the firm's total purification costs and the community's environmental damage in the course of the year.

$$\min_{d1,\ldots,dn} \left[\sum_{i=1}^{n} (M_i\ C\ (\bar{Z}_i - d_i) + M_i\ D\ (d_i))\right]$$

$$\sum_{i=1}^{n} = M_i = N$$

Environmental damage is measured in a monetary unit by the function $D\ (d_i)$. Furthermore it is possible for the primary discharge level or output levels to be constant over a period of several days in the course of the year. The year is divided up into M_i periods with the same primary discharge within each period. N is the number of days (Strom, 1988).

Necessary optimum conditions are:

$$C'(\bar{Z}_i - d_i) = D'(d_i)$$

The marginal purification costs are therefore to be equal to the marginal damage for each period. Marginal damage may generally vary from one period to another. Only if the damage function were to prove linear the same marginal damage in each period is obtained. A common charge, t, in the course of the year can either be justified on this basis or because it has been institutionally decided that the charge must be the same for the whole year. The common rate of charge, t, can be defined as:

$$C'(\bar{Z}_i - d_i) = t$$

Although this model is suitable for the purpose of this study, it is not possible to use it because purification costs of individual firms are not available.

3. MARINE POLLUTION IN TURKEY AND IZMIT BAY

3.1. PRESENT CONDITION OF MARINE AND COAST POLLUTION IN TURKEY

The total coastal line in Turkey is 8362 Km. in length. Mediterranean, Agean, Marmara and Black Sea constitute a major role in fishing and in marine transportation. (TÜBİTAK, 1984)

Industrial development, marine transportation, urbanization and tourism have not obeyed the regulations set by the government. Coastal regions and bays have suffered the most from pollution caused by these developments. (TÜBİTAK, 1984)

Black Sea is 420.000 Km^2 in surface area with an average depth of approximately 1300 m. The available data are only for phosphate and biological oxygen demand. Average value for BOD has been determined to be 0.95 mg/l. BOD values have been observed to be high near the surface where as, lower values have been determined as depth increased. Phosphate has been measured to be 0.0175 mg/lt at the surface and 0.225 mg/lt at deeper levels. BOD values have reached to high levels, where as phosphate level is normal. (TÜBİTAK, 1984)

In the Agean Coast the most polluted area is the İzmir Bay. Total length of the Agean coast is 2800 Km. Sources of pollution are the industrial establishments in Aliağa region and domestic wastes

from the city of İzmir. Also, wastes are carried through the rivers of Meriç, Gediz and Büyük Menderes. The region is developed in agriculture, and thus mercury content has reached to high levels due to utilization of pesticides. Nitrate concentration in İzmir Bay region has been determined to be 0.246 mg/lt. Sulphur and cadmium concentrations have been measured to be 0.008 mg/lt and 0.078 mg/lt respectively. All the measurements for nitrate, sulphur and cadmium show a normal level, according to the above results. (TÜBİTAK, 1984)

Mediterranean Sea is exposed to pollution due to the industrial development of surrounding countries. Turkey is located in the north-east part of the region and is the major pollutant of the sea in this region. Between Taşucu and İskenderun coastal area, plants of textile, food, dye, pulp and fertilizer production exist. Total BOD, COD and phosphorus discharges annually are 133000, 513000, 19000 tons respectively. Those annual discharges indicate high amounts. (TÜBİTAK, 1984)

Marmara Sea is the most chemically polluted inland sea in Turkey. The region is ecologically damaged since the sea is closed to currents for natural purification. In the past, wastes of İstanbul were discharged to the sea without purification, and as a consequence the pollution has reached high levels. 158000 tons of BOD and 370000 tons of COD are disposed only from İstanbul region annually. Those discharges indicate high amounts. İzmit Bay, which is the most polluted region in Marmara Sea is further examined in the next sections. (TÜBİTAK, 1984)

3.2. ENVIRONMENTAL PREVENTION FUND

In Turkey, "Environmental Pollution Prevention Fund" exists by the law No. 2782, that was enacted on August 11, 1983. The purpose of the fund is to support activities to prevent pollution and improve the existing conditions. In that 45 % of investment costs to prevent environmental pollution could be met by loans provided by the fund.

The establishments that cause environmental pollution should pay a contribution to the fund each month. The establishments are classified into five groups and each group is split into three categories as follows: (Official Gazette, Aug 11, 1983). However, no rules or regulations exist that state the criteria used for categorization.

ESTABLISHMENTS POLLUTING ENVIRONMENT	1st DEGREE	2nd DEGREE	3 rd DEGREE
Group 1	600.000 TL	400.000 TL	200.000 TL
Group 2	400.000 TL	200.000 TL	100.000 TL
Group 3	200.000 TL	100.000 TL	50.000 TL
Group 4	100.000 TL	50.000 TL	25.000 TL
Group 5	50.000 TL	25.000 TL	12.500 TL

The most polluting establishment should pay 600.000 TL each month. The criteria for the establishment's standing could not be determined from authorities or any law, since the collection of these amounts each month has never been applied in practice. As a first step the standing of each establishment is determined and then each month a fixed amount of contribution is collected according to the standing of the firm. These amount to be collected was published in the Environmental Law in August 11, 1983, as stated above.

3.3. POLLUTION IN IZMIT BAY

İzmit Bay, developing as the densest center of Industry in Turkey is being polluted at an increasing rate by domestic waste water, effluents and discharges from industrial premises, greasy wastes from ships; industrial gaseous wastes, and particle pollutants; eroded earth and organic pollutants introduced by the streams.

Pollutants have pronounced detrimental effects on the environmental health and marine life as a consequence of the fact that İzmit Bay is closed to currents. A great water mass with approximately 20 Km in length, and 80 km^2 surface area situated at the east of Değirmendere-Yarımca line, has become an extremely dangerous environment to marine life, and quite unsuitable region for camping and recreation of public. (TÜBİTAK, 1984)

In the past 3 decades, a very fast industrial development and a consequential regional population boom, have brought up a pollution

problem. This problem lead us to limit the use of natural resources, and more over endangered the human lives. Among the overall pollution problems throughout our country, the pollution of İzmit Bay, is the one which forces us to search for rapid solutions due to consequential threatining socio-economic dimensions. (TÜBİTAK, 1984)

The followings are the sources of pollution for İzmit Bay

1. Industrial Waste-water and effluents,
2. Domestic waste-waters,
3. Domestic and Industrial solid wastes,
4. Surface streams arriving to İzmit Bay,
5. Marine transportation throughout the Bay,
6. Surface water at the Bay,
7. İzmit Bay - Marmara Sea Interactions,
8. Air - Water interactions

A long term study had been conducted with the co-operation of public and private sectors along with academic and scientific institutions. (TÜBİTAK,1984)

As a result of this study;

a) The qualitative and quantitative diagnoses of pollutants have been concluded.
b) The cleaning and/or purification alternatives for each pollution source have been determined. Purification is here

meant in a general sense of utilizing all possibilities of reducing primary and secondary discharges such as reducing level of production, substitution of input factors, installation of purification equipment and so on.

The remaining tasks are to constitute an action strategy and plan within the limits of laws and statutes. This action strategy and plan must be achieved with the co-operation of academic and scientific institutions, the authorised representatives of public and private sectors, and administration.

The Key-word in this stage is STANDARDS. The standard to be applied will bring clear understanding to the usage concept of the recipients.

3.3.A. THE BASES TO APPROACH TO WASTE-WATER DISCHARGE STANDARDS

The standards generally comprise the purification technology and its rank of applicability in local conditions. They have to be reviewed and renewed in the course of time by accounting the rehabilitation occurred in recipient media and socio-economic benefits and the economic liabilities brought-up by them.

As such:

"To enable the standards to have consistency and durability, according to the environmental-law number 2782, published in 1983, is

originated from the concept of differentiation of short and long term precautions. Thus, step by step standard applications will determine the realistic structure of the ultimate goal and will bring a meaning to the studies for observation and evaluation of the quality of the recipients"

The basic philosophy of the Environmental Law, is that the cost of all measures to protect environment, should not jeopardize the economical development efforts of the country. For this reason, the standards to be proposed for the principles of environmental protection, should envisage the cost of the investment and operation in such a way that, the investment and dispositon speed of industries suggested by the development plans of the country should be in a complete harmony. Only a system of step by step standards and a package of measures in tune with the development economy can be functional and realistic.

"The main task is an optimization of the investments to be made for the rehabilitation of environmental quality through implementation of standards, in such an acceleration that overall economy should not have negative impacts". (TÜBİTAK, 1993)

The sole control criterion during the success and the restoration of the standards is to observe the recipients. The strategy to be applied for all surface waters, can not be isolated from the activities made on recipients.

It is worthwhile to defend the optimum timing of the purification facilities and more oven than that, a planning for the construction of individual and collective purification facilities.

3.3.B. THE APPROACH FOR INSPECTION OF THE INDUSTRIES DUE TO WASTES AND EFFLUENTS

The most important element in solving the pollution problem of İzmit Bay is the establishment of the regional and collective purification facilities through a canal system.

The industries which reduced their wastes and effluent to a certain level, will have monetary contribution to this approach. A realistic planning is extremely essential, since the time is the most important element for the solution of the triangle of Technology-Recources-Applications.

On the other hand, a very significant pollution source in İzmit Bay is the discharges of the vessels. These discharges will be definitely forbidden and the control of these activities shall be given to Coast Guard organization.

The following improvements were recommended, in the TÜBİTAK 1984 study.

1. In the initial stage, the purification of the waste waters must be encouraged in regional collective purification

facilities. Such a solution can be suggested for Metal Industries in Gebze Region and Dilovası.

2. The following improvements must be implemented by the industry and the inhabitants in order to minimize the pollution and cost of operations:
   - Inter-process precautions (e.g. technology improvements),
   - Raw-Material modifications,
   - Conservative water using practice,
   - Re-cycling of used water and waste-reclaiming,

   These aspects must be persuaded in a certain work-programme and their importance in industry must be emphasized. The scientific studies in these fields must be co-ordinated in an integrity.

3. The importance of advanced technology must be encouraged, the design and construction of large purification facilities in the area should be tendered to well experienced infrastructure consulting and contracting companies.

4. Special training programmes must be arranged in order to increase the number of personnel who will operate and control purification systems.

TÜBİTAK (1984) study also recommended that the government pollution standards should be enforced and followed up by the industries and the inhabitants.

4. DATA GATHERING, MODEL SPECIFICATION AND APPLICATION

4.1. DATA GATHERING

Major data used in this study are the loadings of wastes in volume, discharged to the sea by the establishments, and the cost of the cleaning up project for the eastern part of the bay.

The first contact was made with the director of the environmental pollution prevention department at the Ministry of Environment, in November 1993. Required data, were not available at the ministry. We were advised to visit the local government and administration units in İzmit to collect the data, since each city in Turkey has its own unit responsible of environmental pollution. Furthermore, we were also told that data related to environmental pollution in that city, including the financial aspects, are only available in the responsible units of that city's administration. Consequently, we were led to believe that there is no flow of information from the individual units to the ministry.

Following the advise, an appointment was made with the director of the environmental pollution prevention unit in İzmit. Data about the wastes discharged by each company were not publicly available. The only data available was in the report prepared by TÜBİTAK in 1984. In this report wastes discharged by some of the establishments were listed. It was not possible to get information

about the costs of the cleaning up project, since this type of information is considered to be confidential, and is not open to public. After returning to Ankara contacts were made with the president of the Turkish Contractors Association. Through the help of this association, the name and the adress of the firm, Veziroğlu İnşaat, that won the bid of the cleaning project was obtained.

Veziroğlu İnşaat, located in Ankara is an infrastructure construction company. The personnel of the company were very helpful, and they supplied us with the costs of the cleaning up project. They have also provided us with a copy of the study on wastes discharged by the establishments in the eastern part of the bay, which was prepared by TÜBİTAK in February 1993. Veziroğlu İnşaat, had based its feasibility study on the data available from this study.

As a final step an interview was done with Mr. Doğancan Akyürek who was the previous minister of Environment. We asked questions about the environmental regulations and charges that should be paid by pollutant establishments. However, Mr. Akyürek was not able to provide additional information. Furthermore, he believed that the industrial contributions should be cancelled.

4.2. INDUSTRIES WHICH NEED LOCAL INDIVIDUAL PURIFICATION FACILITIES

Table 1 shows the four significant pollutants (BOD, TSM, N, P) and present status of discharges in 1984.

TABLE 1. FOUR SIGNIFICANT POLLUTANTS AND STATUS OF DISCHARGES IN 1984

BOD = Biological oxygen demand
TMS = Total material suspended
N = Total nitrogen
P = Total phosphorus

PARAMETER	SOURCE	NORTH PART		EAST PART		SOUTH PART		BAY	
		t*/day	%	t/day	%	t/day	%	t/day	%
BOD	Industry	78.72	80	22.36	92	0.78	10	101.86	78
	Domestic	19.60	20	1.95	8	6.10	80	27.65	21
	Drainage	0.10	0	0.00	0	0.77	10	0.87	1
	TOTAL	98.42	75	24.31	16	7.65	6	130.38	100
TSM	Industry	60.19	56	6.31	58	1.26	1	67.76	31
	Domestic	29.60	27	2.90	27	9.30	10	41.80	20
	Drainage	18.42	17	1.05	15	85.94	89	106.02	49
	TOTAL	108.21	50	10.86	5	96.50	46	215.58	100
N	Industry	8.79	69	2.13	84	0.01	1	10.93	65
	Domestic	3.95	31	0.40	16	1.24	86	5.59	33
	Drainage	0.04	0	0.00	0	0.19	13	0.23	2
	TOTAL	12.78	76	2.53	15	1.44	9	16.75	100
P	Industry	0.43	30	0.19	66	0.00	0	0.62	31
	Domestic	0.99	70	0.10	34	0.29	94	1.38	68
	Drainage	0.00	0	0.00	0	0.02	6	0.02	1
	TOTAL	1.42	70	0.29	14	0.31	16	2.02	100

Source: İzmit Körfezi'nde Kirlenmenin Önlenmesi ve Giderilmesine Yönelik Çözüm Önerileri, Tübitak, March, 1984
*: tons

Table 2 represents a comparison of domestic effluents with improved stage of effluents of primary industries. The significance of domestic effluents can be seen after the improvement of prime industrial effluents. The improvements include; inter process precautions, raw material modifications, conservative water using practice, recycling of used water and waste redaiming.

TABLE 2. A NEW PROFILE AFTER IMPROVEMENTS IN THE INDUSTRIES WHICH NEED LOCAL-INDIVIDUAL PURIFICATION SYSTEMS PROPOSED BY TÜBİTAK 1984 STUDY

	BOD (ton/day)		TSM (ton/day)		N (ton/day)		P (ton/day)	
INDUSTRY	PRESENT	IMPROVED	PRESENT	IMPROVED	PRESENT	IMPROVED	PRESENT	IMPROVED
Pulp	59.7	18	32.4	4.86	—	—	—	—
Fertilizer	0.79	0.79	2.80	0.42	7.92	1.18	0.28**	0.04
Fermentation	21.46	3.21	1.254	0.18	1.03	1.03	0.22	0.22
Petro-Chemistry	14.7	2.2	3.3	0.5	0.414	0.414	0.011	0.011
Domestic effluents	27	27	43	43	5.52	5.52	1.37	1.37
Total Industrial	96.65	24.2	39.75	5.96	9.364	2.624	0.511	0.271
Total General	123.65	51.2	82.75	48.96	14.884	8.144	1.881	1.641
Percentage Purif Industrial	% 75		% 85		% 72		% 47	
Percentage Purif General	% 59		% 41		% 45		% 13	

Source: İzmit Körfezi'nde Kirlenmenin Önlenmesi ve Giderilmesine Yönelik Çözüm Önerileri, Tübitak, March, 1984

All the industrial effluents other than the industrial effluents indicated above shall be considered as domestic effluents.

The residential domestic effluents will need effective cesspit systems while the industrial domestic effluents will need first stage purification system i.e. neutralization, fat-elimination, sedimentation. First stage purification systems should be constructed by industrial establishments themselves.

The followings are the proposed quality of domestic effluents:

Temperature	:	30°
BOD	:	150 mg/l
TSM	:	50 mg/l
NH_3-N	:	40 mg/l
T-PO_4	:	10 mg/l
Total CN	:	1.0 mg/l
Heavy Metals (Pb,Cv, Ni, Cd, Zn,Cr, As)	:	1.0 mg/l per each
Total Heavy Metals	:	5 mg/l
Detergents	:	10 mg/l
Toxicity	:	1.0
PH	:	6-9
Fat-Grease	:	30 mg/l. (TÜBİTAK, 1993)

4.3. CLEANING UP PROJECT FOR EASTERN PART OF IZMIT BAY

The cleaning project used in this thesis is prepared by Veziroğlu İnşaat. The project consists of the installation of four plants. The plants could be listed as follows;

- Inciniration plant
- Waste water purification plant
- Collector
- Solid waste depositing plant (Veziroğlu İnşaat, 1994).

Both domestic and industrial wastes are to be treated through the plants stated above. Initial investment costs are given in Table 3. Total cost for the project is D.M. 270.985.134. Approximate waste flow to the bay is determined to be 21000 m^3/day. 15000 m^3 consists of industrial waste water, and the remaining 6000 m^3 consists of domestic waste water (Veziroğlu İnşaat, 1994).

Major assumptions made after the project is in life are as follows:

- Each firm should have its individual purification facility. The firm should construct its individual plant and spend additional money, in addition to the contribution that it should pay for the project.

TABLE 3. INITIAL INVESTMENT TABLE

	NAME OF THE ESTABLISHMENT	INITIAL INVESTMENT (DM)	TOTAL (DM)
INCINIRATION PLANT	Mechanical Expenses Construction Expenses Vehicle Expenses Fixture Expenses	152.655.000.- 14.938.128.- 1.485.000.- 1.306.000.-	170.429.128.-
WASTE WATER PURIFICATION PLANT	Waste Water purification plant	22.886.050.-	22.886.050.-
COLLECTOR	Collector	11.432.737.-	11.432.737.-
SOLID WASTE DEPOSITING PLANT	Construction Expenses Fixture Expenses	47.567.963.- 2.535.000.-	50.102.963.-
OTHER EXPENSES	Design Expenses Unexpected Expenses Consulting Expenses Tax Expense	4.707.426.- 50.000.000.- 2.700.000.- 3.700.000.-	16.107.426.-
		TOTAL	270.958.134.-

Source: Veziroğlu İnşaat, 1994.

- The waste water that is going to be treated in the main purification plant should first be treated in the individual purification plant.
- Life of purification facilities is 25 years.
- The individual purification plants should work 24 hours per day (Veziroğlu İnşaat, 1994).
- The following limits should be obtained after the individual treatment.

Parameters		Limit (mg/l)
Biochemical Oxygen Demand	(BOD)	250
Chemical Oxygen Demand	(COD)	800
Total Suspended Solid Material	(TMS)	350
Total Nitrogen	(N)	40

(Official Gazette, Sept. 4, 1988)

The water that is going to be discharged to the bay after the final treatment, should meet the following standards in Table 4, that was published on September 4, 1988 according to the "Water Pollution Control Regulation".

TABLE 4. STANDARDS STATED BY "WATER POLLUTION PREVENTION REGULATION" SEPT. 4, 1988

Parameters (mg/l)	2 Hr. Composite Sample	24 Hr. Composite Sample
BOD (5)	50	45
COD	140	100
Total Phosphorus	10	100
Grease and Fat	50	100
Detergent	5	100
Arsenic	10	100
Antimony	3	100
Cadmium	2	100
Total Chromium	5	100
Copper	2	100
Lead	3	100
Nickel	5	100
Zinc	5	100
Mercury	0.2	100
Silver	5	100
Total Cyanide	10	100
Phenol	10	100
Sulphate	2	100
Chlorine	5	100
Temperature	40°C	At most
pH	4-9	At most

Source: Water Pollution Control Regulation, Sept. 4, 1988.

4.4. RANKING OF ESTABLISHMENTS

A ranking of polluting establishments have been obtained by adding total pollution loads in volume of each parameter for each establishment. The data have been obtained from the "Improvement Study of the east part of İzmit Bay", TÜBİTAK, 1993. Table 5. shows total daily discharge of each establishment and their scale.

Table 6 is a rearrangement of Table 5. Ranking is obtained from the most to the least polluting. Since, MUSTAFA NEVZAT İLAÇ SANAYİ is the least polluting (0.31 kg/day) it is taken to be as the reference. It is assumed that Mustafa Nevzat İlaç Sanayi, scores one, the score of the other establishments could be determined accordingly.

TABLE 5. EAST PART OF IZMIT BAY POLLUTING INDUSTRIAL ESTABLISHMENTS AND TOTAL DISCHARGE LOADS (KG/DAY) FEBRUARY, 1993

	BOD	COD	TMS	Chlorine	Sulphate	Fat-Grease	Nitrogen of Nitrates	Nitrogen of Ammonia	Aluminium	Iron	Copper	Nickel	Zinc	Fluorine	Cadmium	Phosphorus	Chromium	DAILY TOTAL (KG)	SCORE
BASTAŞ, BİRLESİK AYDINLATMA SANAYİİ	19	48	12.6	14.4	1.6	0.04	-	-	-	-	-	-	-	-	-	-	-	95.64	309.-
BEKSA, SANAYİ VE TİC.	0.61	2.95	8.82	372.4	8	0.103	0.107	0.140	0.044	2.361	0.174	0.04	1.856	-	-	-	-	392.15	1265.-
BRISA, SABANCI LASTİK SANAYİİ	27.92	55.6	36.0	103.8	0.5	1.043	-	-	-	0.169	-	-	-	-	-	-	-	244.97	790.-
ÇELİK HALAT VE TEL SANAYİİ	-	6	6	-	-	< 1.2	-	0.135	-	0.585	0.18	0.05	1.56	0.06	0.06	-	-	15.83	51.-
ÇELİKORD A.Ş.	-	7.26	6.99	-	1092	-	6.9	-	-	0.32	-	-	-	-	-	-	-	1113.5	3592.-
DETAŞ, AMBALAJ VE KİMYA SANAYİİ	2.875	2.25	0.175	0.950	0.6	-	-	-	-	0.30	-	-	-	-	-	0.016	-	7.166	23.-
DEVLET SU İŞLERİ 15.ŞUBE MD.LÜĞÜ	3	9	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19.0	61.-
DUSA, ENDÜSTRİEL İPLİK SANAYİİ VE TİC. A.Ş.	8.91	15.31	1.1	145.8	10.85	0.68	0.18	-	-	0.04	-	-	-	-	-	-	-	182.87	590.-
FURSAN, FERMENTASYON ÜRÜNLERİ	373.7	1723.3	416.9	1342.2	27.9	5.36	-	-	-	0.02	-	-	-	-	-	0.04	-	3889.4	12546.-
																Sub Total		5960.5	

TABLE 5. CONTINUATION

	BOD	COD	TMS	Chlorine	Sulphate	Fat-Grease	Nitrogen of Nitrates	Nitrogen of Ammonia	Aluminium	Iron	Copper	Nickel	Zinc	Fluorine	Cadmium	Phosphorus	Chromium	DAILY TOTAL (KG)	SCORE
GOOD YEAR LASTİKLERİ	2.97	9.012	1.706	165.8	16.57	2.13	-	-	-	0.087	-	-	-	-	-	0.16	-	198.44	640.-
HABAS, SINAİ VE TIBBİ GAZLAR	0.2	0.5	0.3	530.	9.	-	-	-	-	-	-	-	-	-	-	-	-	540.0	1742.-
İZMİT BELEDİYESİ MEZHABA MD.LÜĞÜ	183.	296.	22	-	-	3	-	-	-	-	-	-	-	-	-	-	-	504.0	1626.-
KORDSA, KORDBEZİ SANAYİ VE TİC.A.Ş.	8.31	24.5	2.14	174.6	10.74	-	-	-	-	0.013	-	-	-	-	-	-	-	220.3	711.-
LİFLİ RULO VE LEVHA SANAYİİ	42.1	104.6	16.96	219.4	293.2	1.28	-	-	-	0.08	-	-	-	-	-	0.47	-	678.1	2187.-
MUSTAFA NEVZAD İLAÇ SANAYİİ	-	0.29	-	-	-	0.02	-	-	-	-	-	-	-	-	-	-	-	0.31	1.0
PAK GIDA SAN. VE TİCARET	156.4	2023.	73.5	1445.3	65.5	38	-	-	-	0.015	-	-	-	-	-	-	-	3801.7	12264.-
RABAK, ELEKTRO LİTİK BAKIR VE MAMULLERİ	2.175	16.68	11.6	-	-	0.435	-	1.378	0.341	0.176	<0.015	<0.007	0.035	<0.01	<0.0015	-	<0.03	32.88	106.-
TÜRK PHILIPS AYDINLATMA SAN.	3	7.2	1.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12.0	39.-
TÜRK PIRELLİ LASTİKLERİ	4.14	32.15	11.88	-	-	0.66	-	-	-	-	-	-	-	-	-	-	-	48.83	158.-
ZİRAİ DONATIM KURUMU	0.5	0.7	0.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	5.-
																Grand Total		10998.5	

TABLE 6. RANKING OF ESTABLISHMENTS

NAME OF THE ESTABLISHMENT	COMPERATIVE SCORING OF POLLUTANTS
1. FURSAN	12546
2. PAK GIDA	12264
3. ÇELİKORD A.Ş.	3592
4. LİFLİ RULO	2187
5. HABAŞ	1742
6. İZMİT MEZBAHA	1626
7. BEKSA	1265
8. BRISA	790
9. KORDSA	711
10. GOOD YEAR	640
11. DUSA İPLİK	590
12. BASTAŞ	309
13. TÜRK PIRELLİ	158
14. RABAK	106
15. DEVLET SU İŞLERİ	61
16. ÇELİK HALAT	51
17. TÜRK PHILIPS	39
18. DETAŞ AMBALAJ KİMYA	23
19. ZİRAT DONATIM	5
20. MUSTAFA NEVZAD	1 (REFERENCE)
	TOTAL SCORE 38,706

The cost of collective purification facilities to be established is DM. 270.958.134 As the marine pollution is considered in this study the initial investment costs of the collector and waste water purification plant is to be considered. The total cost of the initial investment of the two items from Table 3 is DM. 34.318.787.

4.5. MODEL SPECIFICATION AND APPLICATION

4.5.A. TOTAL CONTRIBUTION COST OF EACH ESTABLISHMENT

The purpose of the study is to design an allocation scheme to determine the contribution of each establishment to the cleaning up cost of the bay, two scenarios are developed and compared at this stage. In the first scenario of the first model, establishments should pay the complete amount of the proposed contributions. In the second scenario, proposed contributions should be paid 75% by the establishments and 25% by the tax payers. In the second model, which is going to be explained in the next section, contributions per parameter for each establishment are determined.

To proceed with the model, we should assign the companies to certain groups as stated on page 16. The law is not clear on the rules for assigning the companies to certain groups. In this study all establishments are assumed to be in Group 1. A subcategorization is assumed as follows:

	TOTAL DISCHARGE	> 1000 (kg/day)	Degree 1
1000 >	TOTAL DISCHARGE	> 500 (kg/day)	Degree 2
	TOTAL DISCHARGE	< 500 (kg/day)	Degree 3

The rates that were given on page 16 are to be collected each month. According to a recent information obtained from the Ministry of Environment, the rates that are to be collected each month are being revised.

Based on the assumptions and the existing rates the charges for each establishment are calculated and presented in Table 7.

TABLE 7. TOTAL DISCHARGES AND CONTRIBUTIONS THAT COULD BE COLLECTED ANNUALLY

NAME OF ESTABLISHMENT	TOTAL DISCHARGE (KG/DAY)	Contributions That Could Be Collected in 1 year in TL	Contributions That Could Be Collected, Converted to D.M. (1 DM: 28.000 TL)
1. FURSAN	3889.4	7.200.000	257
2. PAK GIDA	3801.7	7.200.000	257
3. ÇELİKORD A.Ş.	1113.5	7.200.000	257
4. LİFLİ RULO	678.1	4.800.000	171
5. HABAŞ	540	4.800.000	171
6. İZMİT MEZBAHA	504	4.800.000	171
7. BEKSA	392.15	2.400.000	86
8. BRISA	244.97	2.400.000	86
9. KORDSA	220.3	2.400.000	86
10. GOOD YEAR	198.44	2.400.000	86
11. DUSA İPLİK	182.87	2.400.000	86
12. BASTAŞ	95.64	2.400.000	86
13. TÜRK PİRELLİ	48.83	2.400.000	86
14. RABAK	32.88	2.400.000	86
15. DEVLET SU İŞLERİ	19.0	2.400.000	86
16. ÇELİK HALAT	15.83	2.400.000	86
17. TÜRK PHİLİPS	12.0	2.400.000	86
18. DETAŞ AMBALAJ KİMYA	7.166	2.400.000	86
19. ZİRAT DONATIM	1.4	2.400.000	86
20. MUSTAFA NEVZAD	0.31	2.400.000	86

If the life of purification facilities is 25 years, the installation cost for one year is DM. 34.318.787 /25 which is DM. 1.372.752. If the operation and maintenance cost is assumed to be 30 % of this amount, then the total annual cost will be DM. 1.784.578. Since, reference firm is MUSTAFA NEVZAD İLAÇ SANAYİ, the amount this firm has to pay is DM. 1.784.578 / 38.706 = DM. 35.47.

If similar calculations are done, costs allocated for each establishment can be determined. Table 8 presents a comparison of annual costs allocated for each establishment and legally collectible annual amounts. Percentage that could be met from the prevention fund for annual project cost is also presented in Table 8.

TABLE 8. COSTS ALLOCATED (SCENARIO 1), LEGALLY COLLECTIBLE AMOUNTS AND PERCENTAGE THAT COULD BE MET FROM THE PREVENTION FUND

NAME OF ESTABLISHMENT	COST ALLOCATED IN DM. FOR 1 YEAR SCENARIO 1	LEGALLY COLLECTIBLE AMOUNT IN 1 YEAR (DM.)	PERCENTAGE THAT COULD BE MET FROM THE PREVENTION FUND FOR ANNUAL PROJECT COST OF DM. 34.318.787
1. FURSAN	445000	257	0.00057
2. PAK GIDA	435000	257	0.00059
3. ÇELİKORD A.Ş.	127408	257	0.0020
4. LİFLİ RULO	77573	171	0.0022
5. HABAŞ	61788	171	0.00276
6. İZMİT MEZBAHA	57674	171	0.00296
7. BEKSA	44870	86	0.00191
8. BRISA	28021	86	0.00306
9. KORDSA	25220	86	0.0034
10. GOOD YEAR	22700	86	0.00378
11. DUSA İPLİK	20297	86	0.00424
12. BASTAŞ	10960	86	0.00785
13. TÜRK PİRELLİ	5604	86	0.0154
14. RABAK	3760	86	0.0228
15. DEVLET SU İŞLERİ	2164	86	0.0397
16. ÇELİK HALAT	1809	86	0.0475
17. TÜRK PHİLİPS	1384	86	0.0621
18. DETAŞ AMBALAJ KİMYA	816	86	0.105
19. ZİRAT DONATIM	177	86	0.48
20. MUSTAFA NEVZAD	35.47	86	2.42

According to the above calculations, to meet the contribution of each establishment to the annual cost of DM. 34.318.787 the amount collected for each firm in the prevention fund is not sufficient except for Mustafa NEVZAD İLAÇ SANAYİ and partly for Ziraat Donatım and Detaş Ambalaj.

4.5.B. CONTRIBUTION COST OF EACH ESTABLISHMENT WHEN THE TAX-PAYER CONTRIBUTES AS WELL

In the first scenario allocation scheme of the establishments were developed by assuming that te complete amount of proposed payments were done by the establishments themselves. In the second scenario we assume that 75% of DM. 34.318.787 can be paid by the owners of the industrial establishments. Remaining 25 % of this amount can be met from the government since these industries are helping the Turkish economy and the inhabitants indirectly.

75 % of DM. 34.318.787 to be paid by the industries is DM. 25.739.090 As the life of the purification facilities was assumed to be 25 years, the installation cost for one year is DM. 1.029.563 If the operation and maintenance cost is assumed to be 30 % of this amount, then amount to be paid will be DM. 1.338.432.

As the reference is MUSTAFA NEVZAT İLAÇ SANAYİ the amount that should be paid by the firm must be DM. 1.338.432/38.706 = DM. 34.58 in the first year. Due to an average 5 % inflation level in DM. currency

(CITIBANK, 1994), MUSTAFA NEVZAD İLAÇ SANAYİİ has to pay DM. 34.58x1.05=DM.36.309 in the second year and so on.

Table 9 presents the proposed amounts to be paid by each establishment when the cost is allocated 75% to the establishments and 25% to the inhabitants. Also, a comparison of the two scenarios is available in Table 9.

TABLE 9. COST ALLOCATION FOR SCENARIO 2 AND A COMPARISON WITH SCENARIO 1

NAME OF ESTABLISHMENT	COST ALLOCATED IN THE FIRST YEAR (DM.) SCENARIO 2	COST ALLOCATED IN THE FIRST YEAR (DM.) SCENARIO 1
1. FURSAN	432837	445000
2. PAK GIDA	423108	435000
3. ÇELİKORD A.Ş.	123924	127408
4. LİFLİ RULO	75452	77573
5. HABAŞ	60099	61788
6. İZMİT MEZBAHA	56097	57674
7. BEKSA	43643	44870
8. BRISA	27335	28021
9. KORDSA	24530	25220
10. GOOD YEAR	22080	22700
11. DUSA İPLİK	20355	20297
12. BASTAŞ	10661	10960
13. TÜRK PİRELLİ	5451	5604
14. RABAK	3657	3760
15. DEVLET SU İŞLERİ	2105	2164
16. ÇELİK HALAT	1760	1809
17. TÜRK PHİLİPS	1346	1384
18. DETAŞ AMBALAJ KİMYA	794	816
19. ZİRAAT DONATIM	173	177
20. MUSTAFA NEVZAD	34.5	35.47

When two scenarios are compared it can be concluded that there is not a significant difference with respect to the cost allocations. Both methods could be applied, but the first scenario is more realistic, since the major pollutants are the industrial establishments.

4.5.C. CONTRIBUTION COSTS PER PARAMETER FOR EACH ESTABLISHMENT

In the second method it is possible to be more specific in determining the contributions to cleaning up costs. Table 10 shows the total discharge of each parameter in kg/day and the percentages of each parameter. Cleaning cost of each parameter is obtained by multiplying total cleaning cost (DM. 34, 318, 787) by the percentages. Annual cost per parameter is the division of the value obtained above, by 25.

Proceeding with the calculations, there is need for the percentages of each parameter for every establishment. Table 11 gives the list of the percentages of each parameter for every firm. By multiplying the percentages of each parameter obtained in Table 11 with the annual cleaning up cost per parameter in Table 10 cleaning up cost per parameter for each establishment is obtained as listed in Table 12.

TABLE 10 LOADING AND CLEANING COSTS FOR EACH PARAMETER

	(A)	(B)	(C)	(D)	(E)
		Loading	%	Cleaning cost of	Cleaning cost of each
		per parameter	of parameters	each parameter	parameter annually
1	TOTAL BOD	838.81 Kg/day	0.0700	2402116.434	96,084.6574
2	TOTAL COD	4384.3 Kg/day	0.3658	12555404.78	502,216.1911
3	TOTAL TMS	637.671 Kg/day	0.0532	1826110.786	73,044.4314
4	TOTAL CHLORINE	4514.65 Kg/day	0.3767	12928690.59	517,147.6238
5	TOTAL SULPHATE	1536.46 Kg/day	0.1282	4399990.243	175,999.6097
6	TOTAL OTHERS	72.1 Kg/day	0.0060	206474.1656	8,258.9666
7	TOTAL DAILY	11983.991 Kg/day			

1. Row 1, Column (C) => Row1 / Row7
2. Row 1, Column (D) => 34318787* Row1 / Row7
3. Column (E) = Column(D) / 25
4. Others => Fat-Grease, Nitrogen of Nitrates, Nitrogen of Ammonia, Aluminum, Iron, Copper, Nickel, Zinc, Fluorine, Cadmium, Phosphorus, Chromium
5. The useful life of waste water purification plant and the collector is assumed to be 25 years

TABLE 11. PERCENTAGES OF PARAMETERS FOR EACH ESTABLISHMENT

	BOD (%)	COD (%)	TMS (%)	CHLORINE (%)	SULPHATE (%)	OTHERS (%)
BASTAS	0.0227	0.0109	0.0198	0.0032	0.0010	0.0006
BEKSA	0.0007	0.0007	0.0138	0.0825	0.0052	0.0669
BRISA	0.0333	0.0127	0.0565	0.0230	0.0003	0.0168
CELIK HALAT	0.0000	0.0014	0.0094	0.0000	0.0000	0.0531
CELIKORD A.S.	0.0000	0.0017	0.0110	0.0000	0.7107	0.1001
DETAS	0.0034	0.0005	0.0003	0.0002	0.0004	0.0044
DSI	0.0036	0.0021	0.0110	0.0000	0.0000	0.0000
DUSA IPLIK	0.0106	0.0035	0.0017	0.0323	0.0071	0.0125
FURSAN	0.4455	0.3931	0.6538	0.2973	0.0182	0.0752
GOOD YEAR	0.0035	0.0021	0.0027	0.0367	0.0108	0.0330
HABAS	0.0002	0.0001	0.0005	0.1174	0.0059	0.0000
IZMIT MEZBAHA	0.2182	0.0675	0.0345	0.0000	0.0000	0.0416
KORDSA	0.0099	0.0056	0.0034	0.0387	0.0070	0.0002
LIFLI RULO	0.0502	0.0239	0.0266	0.0486	0.1908	0.0254
MUSTAFA NEVZAD	0.0000	0.0001	0.0000	0.0000	0.0000	0.0003
PAK GIDA	0.1865	0.4614	0.1153	0.3201	0.0426	0.5272
RABAK	0.0026	0.0038	0.0182	0.0000	0.0000	0.0337
TURK PHILIPS	0.0036	0.0016	0.0028	0.0000	0.0000	0.0000
TURK PIRELLI	0.0049	0.0073	0.0186	0.0000	0.0000	0.0092
ZIRAAT DONATIM	0.0006	0.0002	0.0003	0.0000	0.0000	0.0000

TABLE12 CLEANING UP COSTS PER PARAMETER FOR EACH ESTABLISHMENT (DM)

	BOD (DM)	COD (DM)	TMS (DM)	CHLORINE (DM)	SULPHATE (DM)	OTHERS (DM)	TOTAL (DM)
BASTAS	2,176.4267	5,498.3387	1,443.3146	1,649.5023	183.2780	4.5814	10,955.4418
BEKSA	69.8748	337.9187	1,010.3202	42,657.9635	916.3902	552.6365	45,545.1039
BRISA	3,198.2018	6,368.9089	4,123.7559	11,890.1628	57.2744	138.8177	25,777.1215
CELIK HALAT	0.0000	687.2923	687.2926	0.0000	0.0000	438.6731	1,813.2581
CELIKORD A.S.	0.0000	831.6237	800.6959	0.0000	125,087.2615	826.9504	127,546.5316
DETAS	329.3277	257.7346	20.0460	108.8213	68.7293	36.1934	820.8524
DSI	343.6463	1,030.9385	801.8414	0.0000	0.0000	0.0000	2,176.4262
DUSA IPLIK	1,020.6296	1,753.7409	126.0037	16,701.2113	1,242.8542	103.0825	20,947.5221
FURSAN	42,806.8769	197,401.8127	47,755.3840	153,747.3648	3,195.9108	620.7855	445,528.1347
GOOD YEAR	340.2099	1,032.3131	195.4202	18,992.1868	1,898.0732	272.2522	22,730.4553
HABAS	22.9098	57.2744	34.3646	60,710.8504	1,030.9390	0.0000	61,856.3381
IZMIT MEZBAHA	20,962.4257	33,906.4217	2,520.0730	0.0000	0.0000	343.6082	57,732.5286
KORDSA	951.9003	2,806.4437	245.1344	20,000.2160	1,230.2538	1.4890	25,235.4372
LIFLI RULO	4,822.5034	11,981.7963	1,942.7472	25,132.0011	33,585.7006	209.6010	77,674.3496
MUSTAFA NEVZAD	0.0000	33.2191	0.0000	0.0000	0.0000	2.2907	35.5099
PAK GIDA	17,915.4283	231,732.0647	8,419.3349	165,557.3435	7,502.9447	4,354.0885	435,481.2046
RABAK	249.1436	1,910.6727	1,328.7658	0.0000	0.0000	278.3226	3,766.9047
TURK PHILIPS	343.6463	824.7508	206.1878	0.0000	0.0000	0.0000	1,374.5849
TURK PIRELLI	474.2319	3,682.7414	1,360.8394	0.0000	0.0000	75.5938	5,593.4066
ZIRAAT DONATIM	57.2744	80.1841	22.9098	0.0000	0.0000	0.0000	160.3682

Cleaning up cost = Percentage in TABLE VIII * Cleaning up cost in TABLE VII.

In the first model, contribution costs for each establishment were allocated. In the second model, contribution costs were allocated with respect to the parameters. Both models yield approximately the same proposed annual payments. The second model is more accurate, since it is possible to assign costs for each parameter.

5. CONCLUSION

The purpose of the study is to design an allocation scheme to determine the contribution of each establishment to the cleaning up cost of the bay. Two models were developed to determine the contributions. In the first model, contribution costs were allocated for each establishment. Two scenarios were developed in the first model. According to the first scenario, the complete amount of the proposed payment should be paid by the establishment, where as in the second scenario annual costs allocated should be paid 75% by establishments and 25% by inhabitants. In the second model annual costs are allocated per parameter for each establishment.

The firms should be forced to pay their proposed contributions by the end of each year. The value of 1 DM. is estimated to be TL 28 000 (1994, Dec. Central Bank of Republic of Turkey). Accordingly, Mustafa Nevzad İlaç San. will have to pay TL. 966.000 where as FURSAN has to pay TL. 12.000.000.000. Each proceeding year, these payments could be increased according to the inflation rate if necessary.

When the total of cleaning up costs per parameter for each establishment from Table 12 are compared with the costs obtained from Table 8 on page 40. It can be concluded that results turns out to be approximately the same as presented in Table 13.

TABLE 13. COMPARISON OF COST ALLOCATIONS FOR MODEL 1 AND MODEL 2

NAME OF ESTABLISHMENT	PAYMENT IN THE FIRST YEAR FROM SCENARIO 1 (DM) MODEL 1	PAYMENT IN THE FIRST YEAR FROM SCENARIO 2 (DM) MODEL 1	PAYMENT IN THE FIRST YEAR FROM TABLE 12 (DM) MODEL 2
1. FURSAN	445000	432837	445525
2. PAK GIDA	435000	423108	435479
3. ÇELİKORD A.Ş.	127408	123924	127546
4. LİFLİ RULO	77573	75452	77671
5. HABAŞ	61788	60099	61854
6. İZMİT MEZBAHA	57674	56097	57732
7. BEKSA	44870	43643	45544
8. BRISA	28021	27335	25776
9. KORDSA	25220	24530	25234
10. GOOD YEAR	22700	22080	22730
11. DUSA İPLİK	20297	20355	20947
12. BASTAŞ	10960	10661	10955
13. TÜRK PİRELLİ	5604	5451	5593
14. RABAK	3760	3657	3765
15. DEVLET SU İŞLERİ	2164	2105	2176
16. ÇELİK HALAT	1809	1760	1813
17. TÜRK PHİLİPS	1384	1346	1375
18. DETAŞ AMBALAJ KİMYA	816	794	820.85
19. ZİRAT DONATIM	177	173	160.35
20. MUSTAFA NEVZAD	35.47	34.5	35.5

Although, total payments are approximately the same for each establishment the second model is more specific, since contributions are determined per parameter for each establishment. A further study could be conducted to determine the cleaning up cost of each parameter starting with the cleaning costs applied in practice. Hence, it is possible to be more accurate.

The regulations and laws for the charges to be paid by the polluting establishments should be revised. The charges that are to be paid by the pollutants are very low with respect to their profits and damaging costs to the environment.

It is indicated previously that, the basic philosophy of the environmental law is that the cost of all measures to protect environment, should not jeopardize the economical development efforts of the country.

It is obvious that the contributions shown above will directly affect the unit price of products being produced in above mentioned industrial plants.

The taxpayers, who contributed through government, for the establishment of purification plants, may face difficulties to purchase the products with increased prices. They may not efford to purchase the products after the adjustment of the prices.

In this case a differential equation can be established for each firm to arrange the unit price of the product in such a way that it can be affordable by an average purchaser.

This means the percentage of the taxpayers contribution can be increased and eventually the additional tax, paid by an average taxpayer should be smaller than the extra cost of subject product to him during one year period.

Once this system is well understood by the owners of the industrial establishments, it is possible to improve the formule step by step. In later stages, the statistical information during operation can be recorded and used in further calculations.

The cost of damage that the industrial establishments cause should also be taken into consideration. Predicting the cost of damage is very hard. Each year costs involving health problems due to environmental pollution reaches billions of TL. In addition to increased health costs, revenues from tourism and fishing are lost every year. After the project is in life, tourism and fishing industries will be activated in the region while costs spent by the government for health problems will be reduced.

The industrial establishments who are exporting their products, may lose their customers, after the increase of the unit prices of their products, due to their contribution. Government may develop a compensation plan for such companies.

Similar differential equations can be arranged for such exported products in such a way that the firm should keep it competitiveness in international markets. This can also be arranged by increasing the contribution of the taxpayers. The taxpayer shall pay such an additional tax, but indirect effect of the foreign currency flowing into the country shall improve his life standard.

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